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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Green et al.
Application Serial No.: To be assigned
Filed: Concurrently herewith
For: DATA PROCESSING SYSTEM AND METHOD

Date: December 2, 2003

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To complete the requirements of 35 USC 119, enclosed is a certified copy of the following UK priority application:

GB 0315589.2, filed July 3, 2003.

Respectfully submitted,

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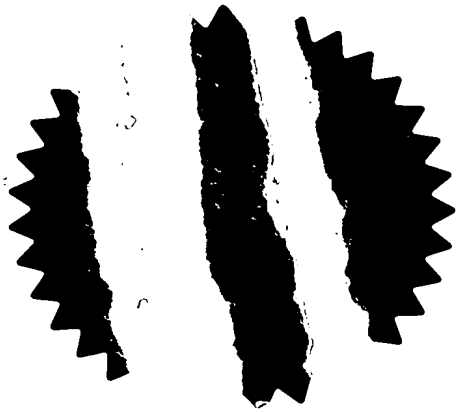

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1. Your reference — P102489GB

2. Patent application number *(The Patent Office will fill in this part)* — 0315589.2 — 3 JUL 2003

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Zoo Digital Group plc
Parkhead House
26 Carver Street
Sheffield
S1 4FS

Patents ADP number *(if you know it)* 8374001001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — Data Processing System and Method

5. Name of your agent *(if you have one)* — Harry Hutchinson

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Harrison Goddard Foote
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S1 2QD

Patents ADP number *(if you know it)* 7914237001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Signature Harry Hutchinson Date 3 July 2003

12. Name and daytime telephone number of person to contact in the United Kingdom Harry Hutchinson 0114 274 3702

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DATA PROCESSING SYSTEM AND METHOD

Field of the Inv ntion

The present invention relates to a data processing system and method and, more particularly, to such a system and method for generating random numbers.

Background to the Invention

Many computer applications call for the use of random numbers, which are employed to give unpredictability to the behaviour of a program. Many computer platforms provide a so-called random number generator, which is typically a RND(N) function that returns a random number in the range of 0 to N-1 (or sometimes 1 to N). It will be appreciated by those skilled in the art that the word "random" is a misnomer since the random numbers produced are usually created using a linear congruential generator (LCG). An LCG sequence generator calculates a series of numbers, r_i, of the form $r_{i+1}=F(r_i)$. Successive numbers in the number sequence are a function of previous numbers. If the RND(N) function performs fairly, each invocation of the function should yield values 0 to N-1 with equal probability. Typical, an LCG will have a large period (that is, the sequence will produce a large number of values before it repeats). If an application requires RND(N), where N is relatively small, then the output of the LCG is manipulated to yield a value that lies in the range 0 to N-1. For example, the result of each step of the LCG can be taken to modulo n in order to produce values in the required range. As a consequence, repeated calls of RND(N) can return repetitions of values before N values have been returned.

The DVD-Video specification as published by the DVD Forum supports a random number function, RND[N], to return a random number within a specified range. However, the specification does not contain any explicit technical guidance to implement this function. It is well known within the industry that some manufacturers have implemented the function in a way that their DVD players always generate the same random number sequence. Such a situation can occur when an LCG is seeded with a constant value. Consequently, companies engaged in authoring DVD-Video discs cannot assume that a different random number sequence will be generated each time a disc is played. This is particularly problematical for games, such as quizzes, where, for some devices, it can result in the same question sequence being delivered each time the disc is played.

Another feature of DVD-Video is the counter mode of the GPRM registers. A

GPRM can be placed in counter mode such that its value is incremented by one for each elapsed second from the moment the counter mode is invoked. This feature can be used effectively to seed an LCG with a value that is time-dependent and likely to change as between successive plays of a disc. While this may go some way to overcoming the limitation of players that have a deficient RND implementation, some manufacturers have defective implementations of the counter feature such that registers are incorrectly incremented in contrast to the DVD-Video specification requirements. Furthermore, it is known that there are some DVD players that have defective implementations of both the RND function and the counter mode of the GPRMs.

It is an object of embodiments of the present invention at least to mitigate some of the problems of the prior art.

Summary of Invention

Accordingly, a first aspect of embodiments of the present invention provides a data processing system comprising means for playing an interruptible or skipable video sequence; and a random number generator for generating a random number associated with an interruption of the interruptible or skipable video sequence.

Advantageously, embodiments of the present invention allow a DVD implementation independent random number generator to be realised that is not beset with at least some of the above mentioned problems.

A further aspect of embodiments of the present invention provides a data processing system comprising a reader to read data representing a video sequence and a number of associated data each having a corresponding command; a presentation engine for outputting the video sequence derived from the data representing the video sequence, a navigation engine, responsive to an event, to invoke one of the corresponding commands according to the output of the video sequence; and means to derive a first value from the invoked command of the corresponding commands. It will be appreciated that the reader might form part of a DVD player or DVD drive to read data from a DVD.

A still further aspect of embodiments of the present invention provides a storage medium comprising data representing a video sequence and a number of associated data each having a corresponding command; and data to derive a first value from one of the corresponding commands in response to an event. Preferably, the storage medium is a DVD.

Other features of the invention are described below and claimed in the claims.

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

figure 1 shows a skipable sequence according to an embodiment of the present invention; and

figure 2 depicts a flowchart according to an embodiment.

Description of the Preferred Embodiments

Figure 1 shows an assembly of data structures 100 used by embodiments of the present invention. The assembly 100 comprises an interruptible or skipable video sequence 102 having a number of group-of-pictures structures GOP 1 to GOP N. Each group-of-pictures structure GOP 1 to GOP N has an associated button set 104 to 110. Each button set 104 to 110 comprises a respective active button 112 to 118. Each button set 112 to 118 has an associated button command 120 to 126 that is performed in response to a navigation engine (not shown) detecting invocation of a respective active button 112 to 118.

The video sequence 102 and corresponding button sets 104 to 110 are arranged such that only the button set associated with a currently active or currently playing or processed group-of-pictures structure is able to be invoked. Therefore, for example, the first button set 104 is active during processing of the first group-of-pictures structure GOP 1 and so on. The button sets 104 to 110 are arranged so that, upon generation of a user event, such as, for example, the user depressing the "OK" button of a remote control (not shown), the corresponding button command 120 to 126 is invoked.

Prior to playing the initial video sequence 102, one of the GPRMs (not shown) is initialised using a value. Preferably, the initialisation value is a random value generated using, for example, the inherent RND function provided by DVD players. The initialised GPRM is then set to counter mode. This second step of setting the GPRM to counter mode is optional.

A button command has the following format

ADD<GPRM><value>; LNK<next-sequence>.

This command results in adding the value represented by <value> to the content of register <GPRM>, that is, the register initialised using the random value, and then linking or jumping to the next or a further video sequence identified by <next-sequence>. Preferably, the value of <value> is unique or distinct for each button set of the sequence. In an embodiment, the values chosen for <value> are the same as the GOP numbers. Therefore, for example, assuming the user presses "OK" during the processing or playing of the first group of pictures structure GOP1, the value 1 is added to the GPRM, during the second group-of-pictures structure GOP2, the value 2 is added to the GPRM and so on. Alternatively, the values used for <value> can be non-sequential or, themselves, random numbers.

Preferably, the video sequence 102 is arranged to repeat, which will force the user to press "OK" to advance the programme and a post command is added to the sequence in the form

ADD<GPRM><value2>,

where <GPRM> is the register initialised previously and <value2> is a further number added to the content of the GPRM upon repetition of the sequence.

If, as is the case in preferred embodiments, the values associated with the button commands are sequential and start from the value "1", it will be appreciated that the value for the mth GOP has the value m. It will be appreciated that ADD<GPRM><value2> is a command that is executed each time the whole of the video sequence 102 has been played.

When a random number is subsequently required, the previously initialised GPRM is returned to normal register mode and its current value is used as the random number. It will be appreciated that since the point at which a user chooses to skip the video sequence might vary as between plays, it will, typically, result in a different value being contained within the GPRM even on devices that have defective implementations of the RND function and defective register counting mode implementations.

Referring to figure 2, there is shown a flowchart 200 of the steps performed by an embodiment of the present invention. One of the GPRM registers is selected and initialised with a random value using the inherent RND function at step 202. At step 204, the selected GPRM register is set to counter mode. At step 206, the video sequence is played by processing the first, or next, GOP structure to produce the video sequence or, at least, part of

a video sequence by the navigation and presentation engines (not shown) as is conventional within a DVD player. At step 210, which is performed, preferably, very shortly after, before or substantially simultaneously, with step 208, a menu (not shown), comprising the button of the button set corresponding to the currently played GOP structure, is made active for the duration of the video sequence currently being played. A test is performed, at step 212, to determine whether or not a user event such as, for example, the "OK" button (not shown) has been depressed. If it is determined that a user event has occurred or has been detected, the corresponding button command is invoked at step 214, which will involve adding an appropriate value to the GPRM. The associated LNK aspect of the command is also invoked at step 214, which leads to the playing of the next video sequence at step 216.

If the determination at step 212 is negative, a test is performed at step 218 to determine whether or not there are further GOP structures to process. If the determination at step 218 is positive, a test is performed at step 220 to determine whether the most recently processed GOP structure was the last GOP structure of the video sequence 102. If the determination at step 220 is negative, processing continues at step 208 where the next GOP is retrieved and processed. However, if the most recently processed GOP structure was the last such structure of the video sequence 102, a predetermined value, <value2>, is added to the GPRM at step 222 and processing then continues at step 208 where the first group of pictures structure GOP 1 is retrieved again.

If the determination at step 218 is negative, it is determined at step 224 whether the video sequence 102 has been arranged to loop or repeat automatically. It will be appreciated in most preferred embodiments that the video sequence 102 will be arranged to repeat whereupon processing continues from step 220. However, if the video sequence is not arranged to repeat, processing terminates and the current value of the GPRM is used as the random number or at least as a seed for a random number generator or random number sequence generator.

In preferred embodiments, the above calculated number, that is, the number contained within the GPRM is used as a seed value for a LCG algorithm that is used to calculate a non-repeating sequence of pseudo-random numbers, that is, the generated sequence does not contain a repetition of any of the numbers until the whole of the sequence has been generated. However, once the full sequence has been generated, that full sequence will, itself, repeat. Preferably, the value contained within the GPRM is used as the first value, r_1, in the equation

$r_{i+1}=(a.r_i+b) \bmod c,$

where c is a prime number and a and b are constants selected according to a desired level of performance of the LCG, that is, according to the quality of the random numbers required.

It will be appreciated that embodiments can be realised in which multiple video sequences together with respective button sets as described above are used to generate the random number or respective random numbers such that the ultimately used random number is associated with or derived from data associated with those multiple video sequences or the embodiments are arranged to produce a number of random numbers using the multiple video sequences.

Although the above embodiments have been described with reference to an LCG, embodiments of the present invention are not limited to such LCGs. Embodiments can be realised in which other generators are used. For example, two or more LCGs can be combined to produce a Combined Linear Congruential Generator (CLCG) in which the two LCGs are combined usually by subtraction or ex-or. Still further, Recursive or Extended LCGs can be used to improve the randomness of low order bits that tend to be less random in LCGs. Other generators that might be used, having obtained a seed number, are Multiple Recursive Generators, Inverse Congruential Generators, Combined Inverse Congruential generators, Multiply with Carry Generators, Multiply or Single Feedback shift registers, Generalised Feedback Shift Registers including Twisted Feedback Shift Registers and Multiple GFSR and so on.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings) and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated

otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

CLAIMS

1. A data processing system comprising a reader to read data representing a video sequence and a number of associated data each having a corresponding command; a presentation engine for outputting the video sequence derived from the data representing the video sequence, a navigation engine, responsive to an event, to invoke one of the corresponding commands according to the output of the video sequence; and means to derive a first value from the invoked command of the corresponding commands.

2. A data processing system as claimed in claim 1 in which the data representing the video sequence comprises a plurality of data structures; each of the data structures being associated with a respective one of the corresponding commands.

3. A data processing system as claimed in claim 2 in which the plurality of data structures comprises a plurality of Group-of-Pictures structures.

4. A data processing system as claimed in any preceding claim in which the associated data comprises at least a command to influence the operation of at least one of the navigation engine and the presentation engine.

5. A data processing system as claimed in any preceding claim in which the corresponding commands comprise associated values used to produce the first value.

6. A data processing system as claimed in any preceding claim in which the corresponding commands comprise respective navigation commands associated with data representing a further video sequence.

7. A data processing system as claimed in claim 6 in which the navigation commands retrieve the data representing the further video sequence and cause the presentation engine to derive the further video sequence from the data representing the further video sequence.

8. A data processing system as claimed in any preceding claim in which the means to derive the first value comprises a register arranged to store a time varying value during the output of the video sequence by the presentation engine.

9. A data processing system as claimed in claim 8 in which the register is a GPRM register set to counter mode.

10. A data processing system as claimed in either of claims 8 and 9 in which the means to derive the first value comprises a combiner to combine the time varying value of the register with data associated with the invoked command.

11. A data processing system as claimed in claim 10 in which the combiner comprises an adder to add the time varying value of the register to the data associated with th invoked command.

12. A data processing system as claimed in any preceding claim in which the means to derive the first value further comprises means to derive the first value from an initialisation value.

13. A data processing system as claimed in claim 12 in which the initialisation value is generated by a random number generator.

14. A data processing system as claimed in any preceding claim further comprising means to generate a sequence of values from the first value.

15. A data processing system as claimed in claim 14 in which the means to generate the sequence comprises means to generate the sequence with a predeterminable number of non-repeating values.

16. A data processing system as claimed in either of claims 14 and 15 in which the means to generate the sequence comprises a calculator to perform an iterative operation to calculate the values of the sequence.

17. A data processing system as claimed in claim 16 in which iterative operation calculates $r_{i+1}=ar_i+b \bmod c$, where a and b are constants, r_1 is the first value and c is prime.

18. A storage medium comprising data representing a video sequence and a number of associated data each having a corresponding command; and data to derive a first value from one of the corresponding commands in response to an event.

19. A storage medium as claimed in claim 18 in which the data representing the video sequence comprises a plurality of data structures; each of the data structures being

associated with a respective one of the corresponding commands.

20. A storage medium as claimed in claim 19 in which the plurality of data structures comprises a plurality of Group-of-pictures structures.

21. A storage medium as claimed in claim 20 in which the associated data comprises at least a command to influence the operation of at least one of a navigation engine and a presentation engine.

22. A storage medium as claimed in any of claims 18 to 21 in which the corresponding commands comprise respective navigation commands associated with data representing a further video sequence.

23. A storage medium as claimed in any of claims 18 to 22 in which the navigation commands retrieve the data representing the further video sequence and cause the presentation engine to derive the further video sequence from the data representing the further video sequence.

24. A storage medium as claimed in any of claims 18 to 23 further comprising a command to arrange for a register to produce a time varying value during output of the video sequence by the presentation engine.

25. A storage medium as claimed in claim 24 in which the command to arrange for the register to produce the time varying value comprises a command to cause a GPRM to assume a counter mode.

26. A storage medium as claimed in either of claims 24 and 25 further comprising data to derive a first value, in response to an event, from one of the corresponding commands.

27. A storage medium as claimed in any of claims 24 to 26 in which the data to derive the first value further comprises data to derive the first value from an initialisation value.

28. A storage medium as claimed in claim 27 in which the initialisation value is generated by a random number generator.

29. A storage medium as claimed in any of claims 24 to 28 further comprising data to generate a sequence of values from the first value.

30. A storage medium as claimed in claim 29 in which the data to generate the sequence comprises data to generate a sequence comprising a predeterminable number of non-repeating values.

31. A storage medium as claimed in either of claims 29 and 30 in which the data to generate the sequence comprises a command to perform an iterative operation to calculate the values of the sequence.

32. A storage medium as claimed in claim 31 in which the iterative operation calculates $r_{i+1}=ar_i+b \bmod c$, where a and b are constants, r_i is the first value and c is prime.

33. A storage medium as claimed in any of claims 18 to 32, in which the medium is a DVD.

34. A data processing system comprising means to play an interruptible or skipable video sequence; and a random number generator for generating a random number associated with an interruption of the interruptible or skipable video sequence.

35. A data processing method comprising the steps of playing an interruptible or skipable video sequence; and generating a random number associated with an interruption of the interruptible or skipable video sequence.

36. A data processing system substantially as described herein with reference to and/or as illustrated in the accompanying drawings.

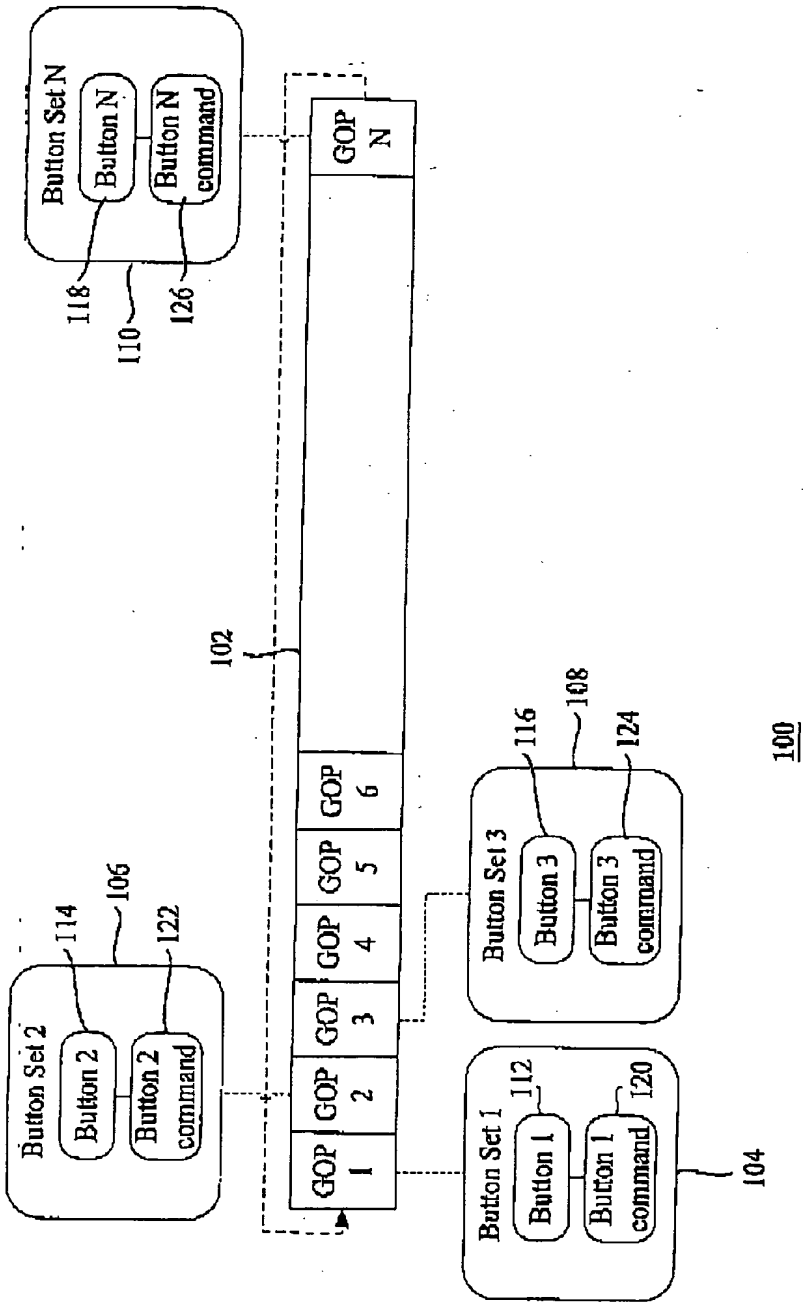
37. A storage medium substantially as described herein with reference to and/or as illustrated in the accompanying drawings.

ABSTRACT

Data Processing System And Method

Embodiments of the present invention relate to a data processing system comprising means to play an interruptible or skipable video sequence; and a random number generator for generating a random number associated with an interruption of the interruptible or skipable video sequence.

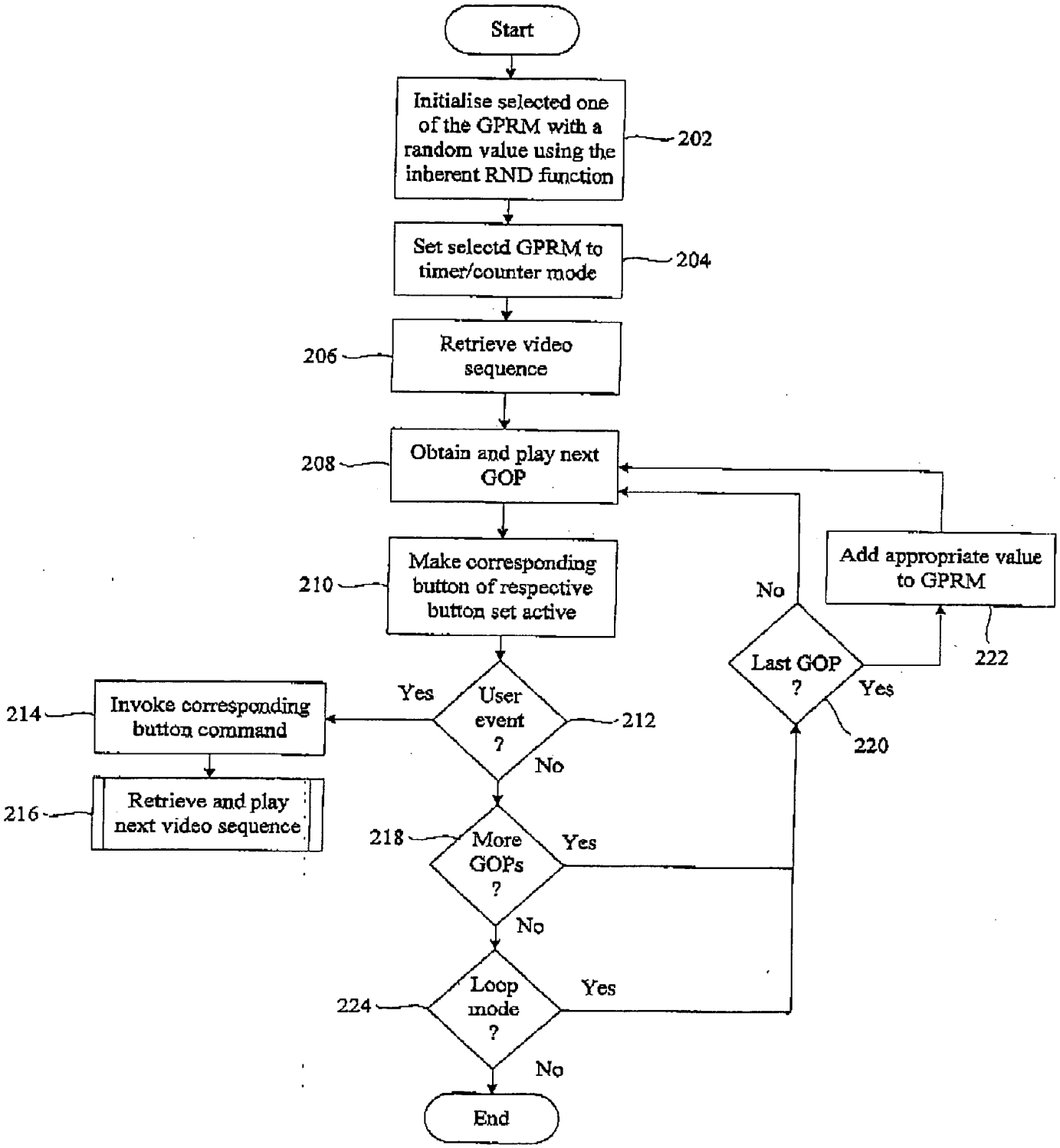
(Figure 1)


Button Set N
Button N
Button N command
118
110
126
GOP N
GOP 6
GOP 5
GOP 4
GOP 3
GOP 2
GOP 1
102
Button Set 2
Button 2
Button 2 command
114
106
122
Button Set 3
Button 3
Button 3 command
116
108
124
Button Set 1
Button 1
Button 1 command
112
120
104
100

1/2

Figure 1

Figure 2


Start
Initialise selected one of the GPRM with a random value using the inherent RND function
202
Set selectd GPRM to timer/counter mode
204
206
Retrieve video sequence
208
Obtain and play next GOP
210
Make corresponding button of respective button set active
User event ?
212
Yes
214
Invoke corresponding button command
216
Retrieve and play next video sequence
No
218
More GOPs ?
Yes
No
224
Loop mode ?
Yes
No
End
Last GOP ?
No
Yes
220
Add appropriate value to GPRM
222

200